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MODEL REDUCTION OF FLOW THROUGH FRACTURED MEDIA WITH UNCERTAINTY QUANTIFICATION

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Flow through fractured media plays a critical role in many subsurface applications such as hydrocarbon extraction, carbon sequestration, environmental remediation and nuclear waste disposal. This broad class of problems involving coupled fluid flow and fractures where fractures ranging in scale from millimeters to meters dominate system behavior. The multi-scale nature of this problem renders it computationally infeasible when accounting for micro and meso scale structure in larger scale applications. In this work, we use a massively parallel discrete fracture network model, dfnWorks[1], to simulate flow through fractured media where scales vary from millimeters to meters. The massively parallel capabilities allow us to probe questions about flow through fractured material that could be answered previously. We investigate 1) the effect of in-fracture variability on flow, 2) transition from a fracture network with no flow to a percolating network and 3) the percolating backbone that makes up the majority of the flow. We now have the capability to simulate flow through complex fracture networks but fracture information is only known in statistically. Therefore, in order to bound the behavior of the system 1000s of model runs are required to quantify the uncertainty. We exploit the discrete structure of the fracture networks by developing graph-based reduced order models that can be run efficiently. We utilize machine learning [2] and simple physics [1] on our graph-based reduced order models to mimic the high fidelity discrete fracture network models. These reduced order models are run in our uncertainty quantification framework to identify the key characteristic of the percolating backbone.

References

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